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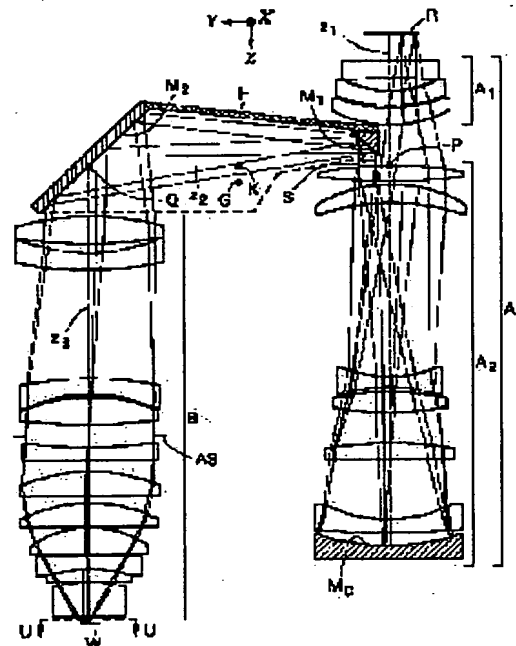   OMURA YASUHIRO

(54) CATADIOPTRIC PROJECTION ALIGNER

(57)Abstract:

PROBLEM TO BE SOLVED: To provide a catadioptic projection aligner, wherein an image is hard to be rotated, even if an optical path deflection member generates tilting and thereby a resolution of quarter-micron unit can be obtained stably.

SOLUTION: In a catadioptic projection aligner in which the reduced image of a first surface R is formed on a second surface W by an optical member comprising a dioptric member, a curved mirror Mc and optical path deflection members M1, M2, an aligner has two or more optical path deflection members M1, M2, and any two optical path deflection members M1, M2 of optical path deflection members are arranged so that the reflection surfaces thereof mutually intersect perpendicularly and are held by a single holding member H.

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CLAIMS

[Claim(s)]
[Claim 1] In the reflective refraction projection aligner which forms the contraction image of the 1st
page on the 2nd page by the optical member containing a dioptrics member, a curved mirror, and an
optical-path deviation member this aligner It is the reflective refraction projection aligner which has
said two or more optical-path deviation members, and is characterized by being arranged and any
two optical-path deviation members in this optical-path deviation member being held by the single
attachment component so that the reflector may intersect perpendicularly mutually.
[Claim 2] It is the reflective refraction projection aligner according to claim 1 which said aligner has
the supporter material which supports said attachment component, passes along the middle point of
the optical axis between said two optical-path deviation members held by said attachment
component, and is characterized by said attachment component being supported by said supporter
material in the flat surface which intersects perpendicularly with this optical axis, or its near.
[Claim 3] The reflective refraction projection aligner according to claim 1 or 2 characterized by not
including a dioptrics member between said two optical-path deviation members held by said
attachment component.
[Claim 4] Said two optical-path deviation members held by said attachment component are reflective
refraction projection aligners according to claim 1, 2, or 3 characterized by being a surface reflecting
mirror.
[Claim 5] The 1st image formation optical system in which said aligner forms said middle image of
the 1st page, The 2nd image formation optical system which forms the re-image formation of said
middle image on said 2nd page, and the 1st optical-path deviation member arranged near said middle
image, The reflective refraction projection aligner according to claim 1, 2, 3, or 4 characterized by
having the 2nd optical-path deviation member which is arranged between this 1st optical-path
deviation member and said 2nd image formation optical system, or is arranged inside said 2nd image
formation optical system.
[Claim 6] For this curved mirror, said 1st image formation optical system is a reflective refraction
projection aligner according to claim 5 characterized by being formed by the concave mirror
including said curved mirror.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the maintenance structure of cata-dioptric system of having the resolution of a quarter micron unit, by using a reflective system especially as an element of optical system about the optical system of the projection aligner used in case a semiconductor device or a liquid crystal aligner is manufactured at a photolithography process.
[0002]
[Description of the Prior Art] In the photolithography process for manufacturing a semiconductor device etc., the projection aligner exposed to tops (it is hereafter named a wafer generically.), such as a wafer or a glass plate with which the image of the pattern on a photo mask or a reticle (it is hereafter named a reticle generically.) was applied to the photoresist etc. through projection optics, is used. The resolution required of the projection optics currently used for the projection aligner is increasing increasingly as degrees of integration, such as a semiconductor device, improve. In order to satisfy this demand, wavelength of the illumination light needed to be shortened and numerical aperture (N.A.) of projection optics needed to be enlarged.
[0003] However, if the class of ** material which is equal to practical use with the absorption of light will be restricted if the wavelength of the illumination light becomes short, and wavelength is set to 300nm or less, the ** material which can now be used practically will serve as only synthetic quartz and fluorite. Since it is not separated from it so that both Abbe number is enough to amend chromatic aberration, amendment of chromatic aberration becomes difficult. Moreover, since the optical-character ability called for is very high, it is necessary to make each aberration into non-aberration mostly. In order to attain this by the dioptric system which consists of only lens groups, many lenses are needed and increase of the cost for manufacturing reduction and optical system of permeability cannot be avoided.
[0004] On the other hand, the reflecting optical system using power, such as a concave mirror, can make non-aberration mostly various kinds of aberration including chromatic aberration, without causing the increment in lens number of sheets according to the so-called cata-dioptric system which combined a reflecting optical system and dioptric system, in order for there to be no chromatic aberration and to indicate the contribution to the reverse PETTSU bar sum to be a lens moreover. The various techniques which constituted projection optics according to such cata-dioptric system have been proposed. As those typical things, JP,63-163319,A, JP,7-111512,B, JP,5-25170,B, and USP-4,779,966 grade are indicated.
[0005]
[Problem(s) to be Solved by the Invention] Generally, by cata-dioptric system, in order to divide the optical path of the other outward trip, and the optical path of the return trip from a concave mirror into a concave mirror, it is necessary to use an optical-path deviation member. Here, special aberration is not produced even if these optical members rotate to the circumference of an optical axis, since the dioptrics member and the concave mirror are formed in the optical-axis symmetry. However, there are an incident light shaft and a injection optical axis in an optical-path deviation member, and it is not formed in the optical-axis symmetry. So, if an optical-path deviation member rotates to the circumference of an incident light shaft or it rotates to the circumference of a injection optical axis, a rotation of image will be caused. Moreover, deformation of an image will be caused if

an optical-path deviation member rotates to the circumference of the shaft which intersects perpendicularly with the both sides of an incident light shaft and a injection optical axis.

[0006] Thus, in order to be stabilized and to obtain the image of the resolution of a quarter micron unit since a rotation of image and deformation occur greatly if the optical-path deviation member of cata-dioptric system produces a tilt (rotation), a severe demand will be imposed also to vibrationproofing so that a severe demand may be imposed to the inclusion location of an optical-path deviation member and an optical-path deviation member may be maintained in the location. For this reason, on the design, although cata-dioptric system was superior to dioptric system, it had become a big trouble at the time of manufacturing cata-dioptric system actually. Even if, as for this invention, an optical-path deviation member produces a tilt in view of this point, it is hard to produce a rotation of image, therefore let it be a technical problem to offer the reflective refraction projection aligner which is stabilized and can obtain the resolution of a quarter micron unit.

[0007]

[Means for Solving the Problem] By the optical member which is made in order that this invention may solve the above-mentioned technical problem, namely, contains a dioptrics member, a curved mirror, and an optical-path deviation member In the reflective refraction projection aligner which forms the contraction image of the 1st page on the 2nd page this aligner Having said two or more optical-path deviation members, any two optical-path deviation members in this optical-path deviation member are reflective refraction projection aligners characterized by being arranged and being held by the single attachment component so that the reflector may intersect perpendicularly mutually.

[0008]

[Embodiment of the Invention] Hereafter, the gestalt of operation of this invention is explained to a detail using a drawing. Drawing 1 shows the optical-path Fig. of projection optics used for the reflective refraction projection aligner by the 1st example of this invention. This projection optics forms the middle image S of the pattern on Reticle R according to the 1st image formation optical system A, and forms the re-image formation of the middle image S on the sensitization side of Wafer W according to the 2nd image formation optical system B. The optical axis (the 1st optical axis z1) of the 1st image formation optical system A is arranged at the vertical Z direction. Moreover, the 1st image formation optical system A consists of a pre-group A1 and a rear group A2, and the concave mirror MC is arranged at the rear group A2, therefore the rear group A2 serves as both-way optical system. And the middle image S of the pattern by the 1st image formation optical system A is formed in the middle of a pre-group A1 and a rear group A2. the near location of the middle image S -- the 1st -- plane mirror M<SUB>1 is arranged, with this plane mirror M1, the 90 degrees of the 1st optical axis z1 of the 1st image formation optical system A are bent, and it is the 2nd optical axis z2 prolonged in the direction of right-and-left Y. The 2nd plane mirror M2 is arranged at the 2nd optical axis z2, the 90 more degrees of the 2nd optical axis z2 are bent by this plane mirror M2, and it is the 3rd optical axis z3 prolonged in a vertical Z direction with it.

[0009] Therefore, if Point P is on a flat surface including the reflector of the 1st plane mirror M1 when the intersection of the 1st optical axis z1 and the 2nd optical axis z2 is made into Point P, and the intersection of the 2nd optical axis z2 and the 3rd optical axis z3 is made into Point Q, Point Q is on a flat surface including the reflector of the 2nd plane mirror M2, and Segment PQ serves as the 2nd optical axis z2. Moreover, two plane mirrors M1 and M2 intersect perpendicularly mutually, and are making [as opposed to / both / the 2nd optical axis z2] the include angle of 45 degrees. And the 2nd image formation optical system B is arranged at the 3rd optical axis z3, and aperture-diaphragm AS is arranged inside this 2nd image formation optical system B.

[0010] Since, as for this projection optics, the 1st image formation optical-system rear group A2 serves as both-way optical system, in a use field, the optical axis z1 of a reticle pattern side and a wafer sensitization side and the location on z3 do not become. That is, the lighting field of the illumination-light study system (un-illustrating) which illuminates a reticle pattern serves as the shape of a slit long in the direction of X before and after it is the shape of a long slit in the direction of X before and after removing the 1st optical axis z1, consequently the exposure field Wa of projection optics also removed the 3rd optical axis z3. And by scanning Reticle R and Wafer W synchronizing with the direction of right-and-left Y, the whole region of a reticle pattern is imprinted

to the sensitization side of a wafer.

[0011] The major characteristics of the projection optics of the 1st example are N.A.:0.75 scale-factor:0.25 time use wavelength:193.3nm (ArF excimer laser) a wafer side.

It comes out. As an exposure field Wa, as shown in drawing 2 (X), the direction die length of direction die-length of order X x right-and-left Y is considering as the 25mmx6mm rectangle region. In addition, drawing 2 (X) is a U-U line expansion view Fig. in drawing 1 .

[0012] The item of the optical member of projection optics is hung up over following Table 1. The 1st column No among the [optical member item] of Table 1 The number of each optical surface from Reticle R side, As for the radius of curvature of each optical surface, and the 3rd column d, the 2nd column r shows the notation of a group with which, as for the effective radius of each optical surface, and the 5th column, the ** material (a blank is air) from each optical surface to the next optical surface belongs, and, as for the 6th column, the notation of each optical member or an optical member belongs, as for the distance on the optical axis from each optical surface to the next optical surface, and the 4th column Reff. Although radius of curvature r and the spacing d on an optical axis make the travelling direction of light forward, whenever it reflects once, they reverse and show positive/negative. Moreover, the quartz in operating wavelength and the refractive index of fluorite are as follows.

quartz: -- 1.560326 fluorite: -- 1.501455 [0013] Moreover, the 39th page and the 52nd page use the aspheric surface, and the 2nd column r about the aspheric surface is top-most-vertices radius of curvature. The configuration of the aspheric surface,

$$z(y)=\frac{y^2/r}{1+\sqrt{1-(1+\kappa)y^2/r^2}}+Ay^4+By^6+Cy^8+Dy^{10}$$

$$+Ey^{12}+Fy^{14}$$

y: Height [from an optical axis] z : the distance r:top-most-vertices radius-of-curvature kappa:constant-of-the-cone A-F:aspheric surface multiplier of the direction of an optical axis from a tangential plane to the aspheric surface expresses, and the value of an aspheric surface coefficient A - F was shown in [aspheric surface data]. About a constant of the cone, each aspheric surface is kappa= 0.

[0014]
[Table 1]
[Optical member item]
No r d Reff 0 infinity 50.0980 R 1 infinity 30.8769 77.96 Quartz A1 2 1358.1393 25.6596 82.00 3 -173.9366 29.5956 82.54 Quartz A1 4 -262.5027 3.9549 93.62 5 -243.7585 32.1846 94.30 Quartz A1 6 -198.6141 79.2508 102.23 7 705.6754 29.6916 128.29 Quartz A2 8 -853.6854 7.1157 128.85 9 243.8837 35.0000 130.00 Quartz A210 393.9524 334.9670 126.2711 -228.4608 20.5261 87.25 Quartz A212 324.6767 7.3561 90.6213 359.7325 40.5663 92.51 fluorite A214 -554.2952 58.0131 94.3415588.9791 33.3872 97.95 Quartz A216 3573.1266 113.1955 97.4817 -249.4612 25.0000 111.74 Quartz A218 -1326.9703 25.8354 126.1319-367.4917 -25.8354 129.94 A2 MC20 -1326.9703 -25.0000 127.54 quartzes A221 -249.4612 -113.1955 117.0122 3573.1266 -33.3872 112.48 Quartz A223 588.9791 -58.0131 111.8924 -554.2952 -40.5663 100.25 Fluorite A225 359.7325 -7.3561 97.3626 324.6767 -20.5261 94.44 Quartz A227 -228.4608 -334.9670 87.5128 393.9524 -35.0000 93.84 Quartz A229 243.8837-7.1157 96.5030 -853.6854 -29.6916 93.81 Quartz A231 705.6754 1.6203 92.0932 infinity 530.0000M133 infinity - 100.0000 M234 -473.4614 -50.8662 130.00 Quartz B35 1218.5628 -18.9785 128.4236 357.1688 -31.0635 128.11 Quartz B37 818.7536 -209.4034129.9338 -571.9096 -31.2079 123.89 Quartz B39-295.8211 -4.7127 119.4840 -291.2028 -53.9868 119.84 Fluorite B41 858.6769 -19.1416 119.0042 - - 24.0577 115.27 AS43 719.7751 -25.0000 113.83 Quartz B44 6715.0030 -22.3498 117.1945 -314.9647 -45.0000 124.79 Quartz B46 -5036.3103 -16.5385 123.5547 -265.1907 -45.0000 120.07 Quartz B48 9375.9412 -1.1109 116.5449 -177.9561 -50.1531 103.37 Quartz B50 -18823.9455 -4.9217 94.9151 1624.4653 -25.0000 93.03 Quartz B-52 -247.3912 -1.0000 74.5453 -210.5206 -24.3364 73.99 Quartz B54-35247.2125 -1.0621 69.2155 -293.7588 -65.0000 63.01 Quartz B56 56893.1197 -12.3837 31.1557 infinity W [aspheric surface data]
No=39 A=-1.3500x10-8 B=-1.2494x10-13 C=-1.3519x10-18 D=-9.1832x10-23 E= 3.6355x10-27

F=-1.6744x10-31No=52 A=-4.8402x10-8 B=-1.1379x10-12 C=-6.8704x10-17 D=-2.8172x10-21 E= 0 F= 0 [0015] Now, in this example, two plane mirrors M1 and M2 are held by the single attachment component H, namely, two plane mirrors M1 and M2 are held as one. This attachment component H has in general the midpoint of the location where it is supported from the front (the direction of +X), and back (the direction of -X) by the supporter material (un-illustrating) set up on the stand (un-illustrating), and the supporter material of order supports an attachment component H by it in the place of the PIBOTARU point G of a 30mm directly under of the middle point K of the 2nd optical axis z2 (namely, segment PQ). Although supporter material is supported so that an attachment component H may not produce any movement, either, actually, an attachment component H may produce rotation and the rotation turns into rotation of the circumference of the X-axis which passes along the PIBOTARU point G, a Y-axis, and the Z-axis.

[0016] Thus, the effectiveness of a configuration of holding two plane mirrors M1 and M2 as one, and making the middle point K of the 2nd optical axis z2 (segment PQ) or its near into the PIBOTARU point G is shown below. As a candidate for a comparison, two plane mirrors M1 and M2 are supported according to an individual, and deformation of an image when the 1st plane mirror M1 rotates, and deformation of an image when the 2nd plane mirror M2 rotates are investigated. Subsequently, based on the configuration of this example, deformation of an image when two plane mirrors M1 and M2 rotate as one is investigated.

[0017] First, the deformation result of an image when the 1st plane mirror M1 rotates independently is explained. Assumed rotation is considered as rotation of the circumference of the X-axis which passes along the PIBOTARU point P, a Y-axis, and the Z-axis by making the intersection P of the 1st optical axis z1 and the 2nd optical axis z2 into a PIBOTARU point, and a rotational direction and a rotational angle of rotation are seen from the direction of +X, respectively, counterclockwise, 3", they are seen from the direction of +Y, are counterclockwise seen from 3" and + Z direction, and are clockwise made into 3." In addition, although the PIBOTARU point P is on the flat surface which extended the reflector of the 1st plane mirror M1, since the 1st image formation optical system A includes both-way optical system, the PIBOTARU point P is not necessarily on the reflector of the 1st plane mirror M1 itself.

[0018] Although it originates in this rotation and an image deforms, the amount of displacement of the mid gear 1 of the exposure field Wa and the four corners 2-5 of the exposure field Wa is shown in Table 2 and drawing 2 . The unit of the amounts dX and dY of displacement shown in Table 2 is nm. Moreover, drawing 2 (X), (Y), and (Z) express the amount of displacement of the points 1-5 by rotation of the circumference of the X-axis, a Y-axis, and the Z-axis, respectively. In addition, rotation of the 1st plane mirror M1 also displaces the location on the wafer side of the 3rd optical axis z3. being shown in Table 2 and drawing 2 -- a variation rate -- the location of the 3rd next optical axis z3 -- a variation rate -- the variation rate of the points 1-5 which remain still more when it pulls back so that it may put on the location of the 3rd front optical axis z3 -- the amount is expressed.

[0019] Similarly, deformation of an image when the 2nd plane mirror M2 rotates independently is shown in Table 3 and drawing 3 . The PIBOTARU point is made into the intersection Q of the 2nd optical axis z2 and the 3rd optical axis z3, and other conditions are the same as the above. Similarly, deformation of an image when two plane mirrors M1 and M2 rotate as one is shown in Table 4 and drawing 4 . The PIBOTARU point is made into the point G of a 30mm directly under of the middle point K of the 2nd optical axis z2 (segment PQ), and other conditions are the same as the above.

[0020]
[Table 2]
[Circumference rotation of the X-axis] [Circumference rotation of a Y-axis] [Circumference rotation of the Z-axis]
Point dX dY dX dY dX dY1 0.0 -14.0 - 106.7 0.0 106.7 0.02 73.2 19.2 - 159.7 -145.3 159.7 145.23 32.9 41.5 - 86.5 -165.4 86.5 165.34 -73.1 19.2 -159.8 145.2 159.7 -145.35 -32.9 41.5 -86.5165.3 86.5 -165.4 [0021]
[Table 3]
[Circumference rotation of the X-axis] [Circumference rotation of a Y-axis] [Circumference rotation of the Z-axis]

Point dX dY dX dY dX dY1 0.0 -7.7 124.8 0.0 - 124.8 0.02 -19.9 -56.1 185.5 191.7 - 185.5 -191.73 - 9.1 -44.3 85.5 186.3 - 85.4 -186.34 19.9 -56.1 185.5 -191.7 -185.5 191.75 9.1 -44.3 85.4-186.3 -85.5 186.3 [0022]

[Table 4]

[Circumference rotation of the X-axis] [Circumference rotation of a Y-axis] [Circumference rotation of the Z-axis]

Point dX dY dX dY dX dY1 0.0 -10.9 18.1 0.0 231.5 -0.12 26.7 -18.4 25.7 46.5 345.3 336.93 12.0 - 1.4 - 1.1 21.0 172.1 351.64 -26.7 -18.4 25.8 -46.4 345.1 -337.05 -12.0 -1.4 -1.0-20.9 171.9 -351.7

[0023] If an object member is rotated to the circumference of the X-axis as shown in drawing 2 - drawing 4 , deformation of an image will occur. Moreover, if an object member is rotated to the circumference of a Y-axis or it rotates to the circumference of the Z-axis, a rotation of image will occur. Among these, when its attention is first paid to rotation of the circumference of the X-axis, as compared with rotation (drawing 2 (X)) independent [1st plane mirror M1] and rotation (drawing 3 (X)) independent [2nd plane mirror M2], it turns out by this example (drawing 4 (X)) that deformation of an image has decreased. That is, in order that deformation of the image at the time of rotation independent [1st plane mirror M1] and deformation of the image at the time of rotation independent [2nd plane mirror M2] may show the inclination of hard flow mostly, according to this example, both deny, it is and deformation of an image decreases. Since an optical axis does not shift like Rubik Cube and the beam-of-light gap to an ideal location hardly arises even if two plane mirrors M1 and M2 shift the degree of isogonism, this is because the yield of aberration is small.

[0024] In addition, as for the PIBOTARU point in the case of holding two plane mirrors M1 and M2 as one, it is desirable to consider as the middle point K of the 2nd optical axis z2 (segment PQ). It is because the distance on the optical axis from Reticle R to Wafer W does not change even if an attachment component will rotate to the circumference of the X-axis which passes along a PIBOTARU point, if a PIBOTARU point is in the middle point K of the 2nd optical axis z2 (segment PQ), so aberration symmetrical with rotation and a scale-factor gap hardly occur.

[0025] From this, a small thing is desirable and, generally the distance KG of the middle point K of the 2nd optical axis z2 (segment PQ) and the PIBOTARU point G is less than 0.2 times of the die length PQ of the 2nd optical axis z2, i.e., KG<=0.2xPQ. .... (1)

It comes out and a certain thing is desirable. Since it is KG=30mm and PQ=530mm, the above-mentioned conditions (1) are filled with this example. Although the PIBOTARU point G may be in the interior of an attachment component H, it has no choice but the to support. Therefore, the realistic support location of an attachment component is good to carry out near the flat surface which intersects perpendicularly with the 2nd optical axis z2 through the middle point K of the 2nd optical axis z2.

[0026] Next, when its attention is paid to rotation of the circumference of a Y-axis, as compared with rotation (drawing 2 (Y)) independent [1st plane mirror M1] and rotation (drawing 3 (Y)) independent [2nd plane mirror M2], it turns out by this example (drawing 4 (Y)) that the rotation of image has decreased. That is, in order that the rotation of image at the time of rotation independent [1st plane mirror M1] and the rotation of image at the time of rotation independent [2nd plane mirror M2] may show the inclination of hard flow mostly, according to this example, both deny, it is and a rotation of image decreases.

[0027] Next, if its attention is paid to rotation of the circumference of the Z-axis, as compared with rotation (drawing 2 (Z)) independent [1st plane mirror M1] and rotation (drawing 3 (Z)) independent [2nd plane mirror M2], the rotation of image will have occurred greatly in this example (drawing 4 (Z)). However, since the attachment component H which holds two plane mirrors M1 and M2 as one makes the direction of Y the longitudinal direction, it is easy the attachment component by reinforcing supporter material at the edge of the longitudinal direction of an attachment component H etc. to control the rotation (and rotation of the circumference of the X-axis) of the circumference of the Z-axis. Furthermore, since Z shaft orientations are the gravity directions, even if rotation of the circumference of the Z-axis arises, the gravity balance of an attachment component H does not necessarily collapse. Therefore, also from this point, the rotation of the circumference of the Z-axis can be controlled easily. Moreover, maintenance is comparatively easy, if a reflective deviation member is a surface reflecting mirror as this example shows. If a thing

like a beam splitter is included to it, support of the weight of an attachment component, furthermore an attachment component will become comparatively difficult.

[0028] Next, the optical-path Fig. of projection optics used for the reflective refraction projection aligner by the 2nd example of this invention is shown in drawing 5 . The main differences with the 1st example of this example are the point that Lens L is arranged between two plane mirrors M1 and M2, and the point that the ** material of all lenses is quartz glass, as shown in this drawing. The major characteristics of the projection optics of the 2nd example are N.A.:0.65 scale-factor:0.25 time use wavelength:193.3nm (ArF excimer laser) a wafer side.

It comes out. As an exposure field Wa, as shown in drawing 6 (X), the direction die length of direction die-length of order X x right-and-left Y is considering as the 25mmx8mm rectangle region. The item of the optical member of the projection optics of the 2nd example is hung up over following Table 5. About the ** material of a lens, since it is a quartz altogether, it is omitting in Table 5. Moreover, each aspheric surface is kappa= 0 and a constant of the cone is E=F=0 among aspheric surface multipliers.

[0029]

[Table 5]

[レンズ諸元]

No	r	d	$R_{o\prime\prime}$	
0	∞	52.5105		R
1	567.1430	40.1245	84.49	A_1
2	3470.8704	2.2743	86.20	
3	12580.6849	29.5354	86.34	A_1
4	919.5973	2.0000	88.19	
5	355.8404	35.8420	89.51	A_1
6	645.8193	78.2133	89.37	
7	523.4723	23.5558	95.17	A_2
8	-1724.9806	14.1444	94.91	
9	-544.7152	22.0000	94.37	A_2
10	-996.4488	0.5000	94.96	
11	222.1244	22.0000	94.48	A_2
12	285.0673	270.9667	91.66	
13	-448.3590	20.0001	69.82	A_2
14	483.2437	7.1773	69.86	
15	450.0000	27.4588	73.46	A_2
16	-581.8071	98.1108	77.12	
17	-164.5653	25.0000	97.01	A_2
18	-686.3758	18.1361	116.87	
19	-274.4169	-18.1361	117.82	A_2 M_c
20	-686.3758	-25.0000	117.22	A_2
21	-164.5653	-98.1108	102.36	
22	-581.8071	-27.4588	99.27	A_2
23	450.0000	-7.1773	98.55	
24	483.2437	-20.0001	96.16	A_2
25	-448.3590	-270.9667	92.30	
26	285.0673	-22.0000	83.28	A_2
27	222.1244	-0.5000	84.79	
28	-996.4488	-22.0000	82.76	A_2
29	-544.7152	-14.1444	80.48	
30	-1724.9806	-23.5558	79.87	A_2
31	523.4723	-0.5000	78.99	
32	∞	255.9374		M_1
33	604.6543	31.2039	116.51	B L
34	-787.6549	200.0000	116.86	
35	∞	-152.7463		M_2
36	-445.7714	-30.0000	103.97	B
37	-10477.3479	-0.5000	102.01	
38	-704.6939	-24.4152	101.24	B
39	-217.6002	-46.6658	96.30	
40	-262.5805	-32.4068	100.37	B
41	-1345.5908	-82.6445	98.92	

42	–	-47.7302	91.14	A S
43	-313.2008	-39.4658	97.58	B
44	584.6659	-0.8283	97.17	
45	-473.1823	-27.4850	94.61	B
46	487.4609	-8.0932	93.17	
47	304.5680	-25.0000	92.05	B
48	1295.3943	-0.6535	87.95	
49	-210.3586	-42.6899	84.21	B
50	-716.6193	-4.1246	76.28	
51	-240.1793	-60.0000	72.13	B
52	1038.2875	-1.1901	55.47	
53	-280.1800	-40.0000	50.65	B
54	-2803.1853	-18.2145	34.10	
55	∞			W

[非球面データ]

No =38   A= 2.1892×10^{-8} B= 2.7825×10^{-13}

          C= 1.4089×10^{-18} D= -6.4967×10^{-23}

No =48   A= -1.3381×10^{-8} B= -4.2757×10^{-13}

          C= 4.5484×10^{-18} D= -2.4978×10^{-22}

[0030] Now, like the time of the 1st example, as a candidate for a comparison, two plane mirrors M1 and M2 are supported according to an individual, and deformation of an image when the 1st plane mirror M1 rotates, and deformation of an image when the 2nd plane mirror M2 rotates are investigated. Subsequently, based on the configuration of this example, deformation of an image when two plane mirrors M1 and M2 rotate as one is investigated. Deformation of an image when the 1st plane mirror M1 rotates independently is shown in Table 6 and drawing 6 . The PIBOTARU point is made into the intersection P of the 1st optical axis z1 and the 2nd optical axis z2, and other conditions are the same as the time of the 1st example. Similarly, deformation of an image when the 2nd plane mirror M2 rotates independently is shown in Table 7 and drawing 7 . The PIBOTARU point is made into the intersection Q of the 2nd optical axis z2 and the 3rd optical axis z3, and other conditions are the same as the above. Similarly, deformation of an image when two plane mirrors M1 and M2 rotate as one is shown in Table 8 and drawing 8 . From the middle point K of the 2nd optical axis z2 (segment PQ), a PIBOTARU point is made to +50mm at a Z direction, and is made into the -10mm point G in the direction of Y, and other conditions are the same as the above. In addition, it is KG=[502+(-10)2] 1 / 2= 51, and since it is PQ=487mm, the above mentioned conditions (1) are fulfilled.

[0031]

[Table 6]

[Circumference rotation of the X-axis] [Circumference rotation of a Y-axis] [Circumference rotation of the Z-axis]

Point dX dY dX dY dX dY1 0.0 -9.8 - 120.1 0.0 120.1 0.02 63.4 20.4 - 176.2 -150.2 176.3 150.13 24.3 38.4 - 78.8 -169.7 78.9 169.74 -63.4 20.4 -176.3 150.1 176.2 -150.25 -24.3 38.4 -78.9169.7 78.8 -169.7 [0032]

[Table 7]

[Circumference rotation of the X-axis] [Circumference rotation of a Y-axis] [Circumference rotation of the Z-axis]

Point dX dY dX dY dX dY1 0.0 0.9 139.8 0.0 - 139.8 0.02 -38.4 -32.3 206.8 201.0 - 206.7 -201.03 - 14.7 -34.3 74.5 189.1 - 74.5 -189.14 38.4 -32.3 206.7 -201.0 -206.8 201.05 14.7 -34.3 74.5-189.1 - 74.5 189.1 [0033]

[Table 8]

[Circumference rotation of the X-axis] [Circumference rotation of a Y-axis] [Circumference rotation

of the Z-axis]
Point dX dY dX dY dX dY1 0.0 -31.0 19.7 0.0 259.9 -0.12 49.4 -44.1 30.6 50.8 390.6 343.23 41.8 -
12.6 - 4.2 19.4 160.9 355.84 -49.4 -44.1 30.3 -50.8 390.4 -343.45 -41.8 -12.6 -4.5-19.4 160.7 -355.9
[0034] If an object member is rotated to the circumference of the X-axis as shown in <u>drawing 6</u> -
<u>drawing 8</u> , deformation of an image will occur. Moreover, if an object member is rotated to the
circumference of a Y-axis or it rotates to the circumference of the Z-axis, a rotation of image will
occur. Among these, if its attention is first paid to rotation of the circumference of the X-axis, as
compared with rotation (<u>drawing 6</u> (X)) independent [1st plane mirror M1] and rotation (<u>drawing</u>
<u>7</u> (X)) independent [2nd plane mirror M2], deformation of the image of tales doses will also have
generated this example (<u>drawing 8</u> (X)) mostly. Since Lens L is caught between two plane mirrors
M1 and M2, a beam-of-light gap is produced because the beam of light reflected with the 1st plane
mirror M1 penetrates Lens L, incidence is carried out to the 2nd plane mirror M2 after that and the
effectiveness that the optical axis by Rubik Cube does not shift will be lost, this is for aberration to
occur. Like previous statement, since the attachment component H makes the direction of Y the
longitudinal direction, it is easy the attachment component by reinforcing supporter material at the
edge of the longitudinal direction of an attachment component H etc. to control the rotation of the
circumference of the X-axis. However, it is desirable not to have the refraction member L among
both, when holding as one two plane mirrors M1 and M2 which make a right angle, and also when
arranging the refraction member L, limiting to about two sheets is desirable.
[0035] Next, when its attention is paid to rotation of the circumference of a Y-axis, as compared with
rotation (<u>drawing 6</u> (Y)) independent [1st plane mirror M1] and rotation (<u>drawing 7</u> (Y))
independent [2nd plane mirror M2], it turns out by this example (<u>drawing 8</u> (Y)) that the rotation
of image has decreased. That is, in order that the rotation of image at the time of rotation
independent [1st plane mirror M1] and the rotation of image at the time of rotation independent
[2nd plane mirror M2] may show the inclination of hard flow mostly, according to this example,
both deny, it is and a rotation of image decreases. Next, if its attention is paid to rotation of the
circumference of the Z-axis, as compared with rotation (<u>drawing 6</u> (Z)) independent [1st plane
mirror M1] and rotation (<u>drawing 7</u> (Z)) independent [2nd plane mirror M2], the rotation of image
will have occurred greatly in this example (<u>drawing 8</u> (Z)). However, as the 1st example described,
it is easy to control the rotation of the circumference of the Z-axis.
[0036]
[Effect of the Invention] As explained in full detail above, according to this invention, the
deformation of the image generated by rotation of an optical-path deviation member was small,
therefore the reflective refraction projection aligner which is stabilized and has the resolution of a
quarter micron unit was able to be offered.

[Translation done.]

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2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] The optical-path Fig. of projection optics used for the reflective refraction projection aligner by the 1st example of this invention
[Drawing 2] The U-U line view Fig. in drawing 1 showing deformation of an image when the 1st plane mirror rotates independently to the circumference of (X) X-axis, the circumference of the (Y) Y-axis, and the circumference of (Z) Z-axis
[Drawing 3] Drawing corresponding to drawing 2 which shows deformation of an image when the 2nd plane mirror rotates independently
[Drawing 4] Drawing corresponding to drawing 2 which shows deformation of an image when the 1st plane mirror and the 2nd plane mirror rotate as one
[Drawing 5] The optical-path Fig. of projection optics used for the reflective refraction projection aligner by the 2nd example
[Drawing 6] The U-U line view Fig. in drawing 5 showing deformation of an image when the 1st plane mirror rotates independently to the circumference of (X) X-axis, the circumference of the (Y) Y-axis, and the circumference of (Z) Z-axis
[Drawing 7] Drawing corresponding to drawing 5 which shows deformation of an image when the 2nd plane mirror rotates independently
[Drawing 8] Drawing corresponding to drawing 5 which shows deformation of an image when the 1st plane mirror and the 2nd plane mirror rotate as one
[Description of Notations]
R -- Reticle W -- Wafer
A -- The 1st image formation optical system A1 -- Pre-group
A2 -- Rear group S -- Middle image
MC -- Concave mirror M1, M2 -- Plane mirror
B -- The 2nd image formation optical system AS -- Aperture diaphragm
H -- Attachment component L -- Lens
z1, z2, z3 -- Optical axis X -- Cross direction
Y -- Longitudinal direction Z -- The direction of a vertical
P -- Intersection of the 1st optical axis and the 2nd optical axis Q -- Intersection of the 1st optical axis and the 2nd optical axis
K -- The middle point of the 2nd optical axis G -- PIBOTARU point
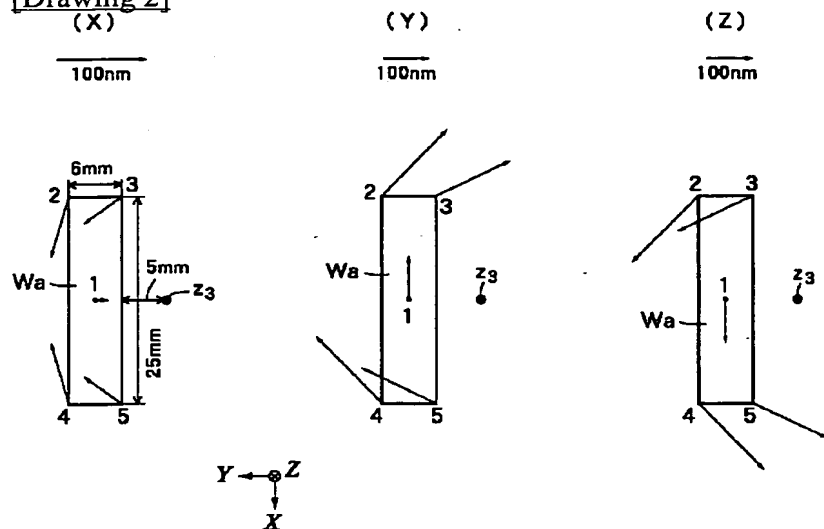

[Translation done.]

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JPO and NCIPI are not responsible for any
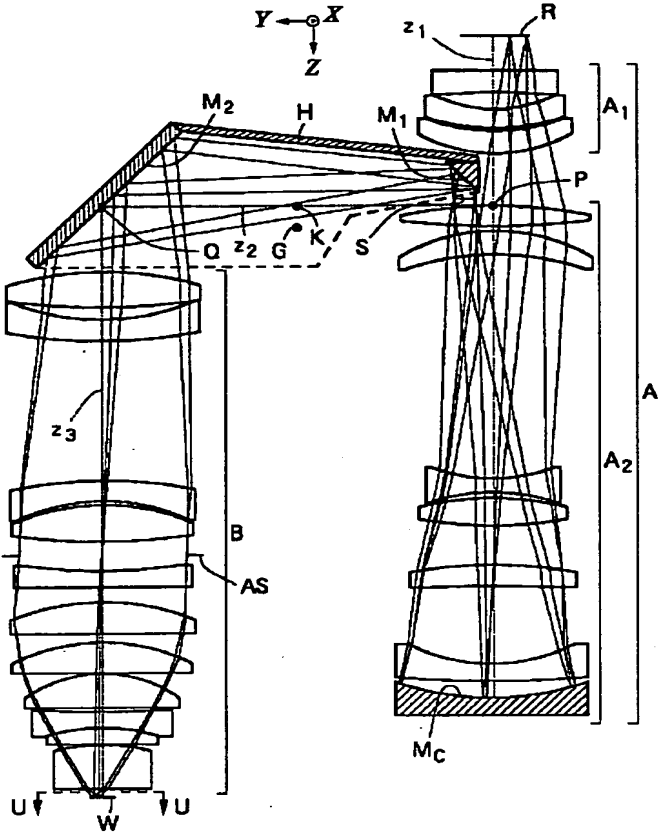**damages caused by the use of this translation.**

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS
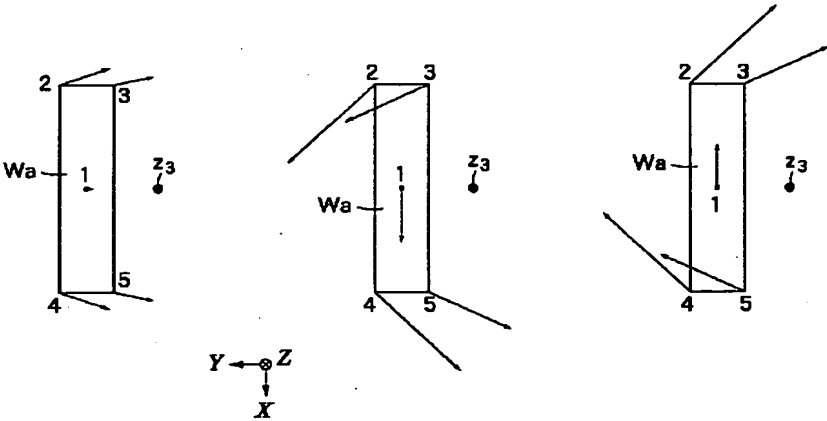

[Drawing 2]

[Drawing 1]
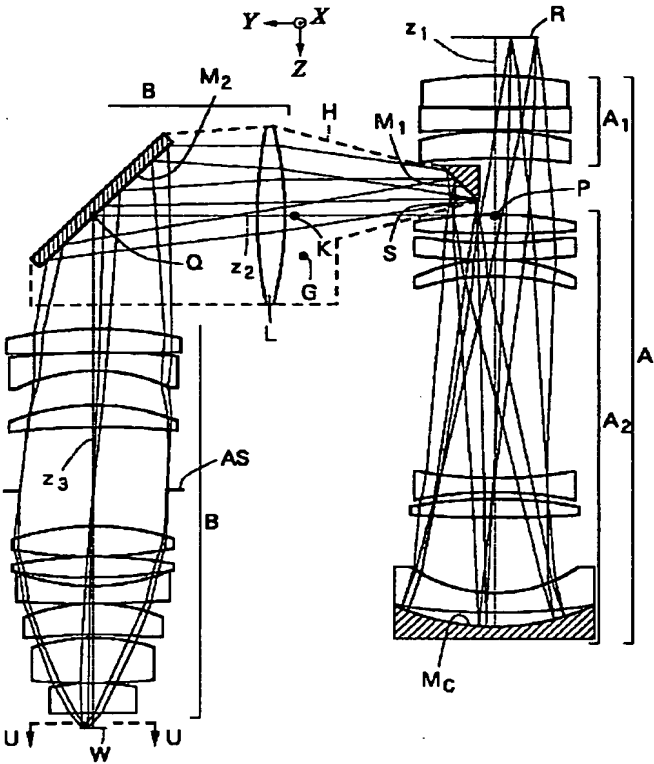
[Drawing 3]

(X)   (Y)   (Z)

100nm   100nm   100nm
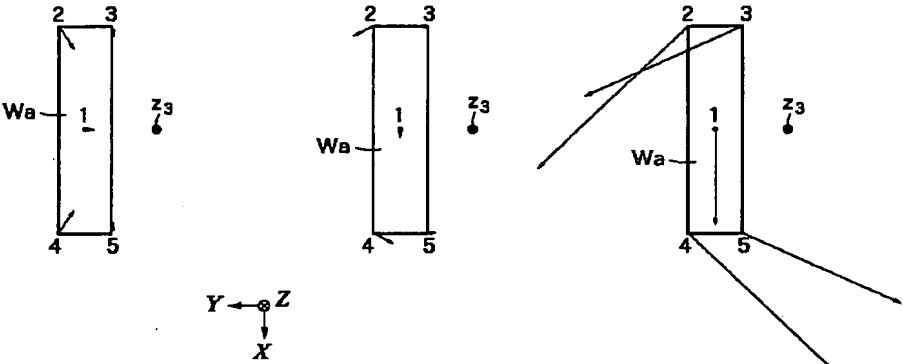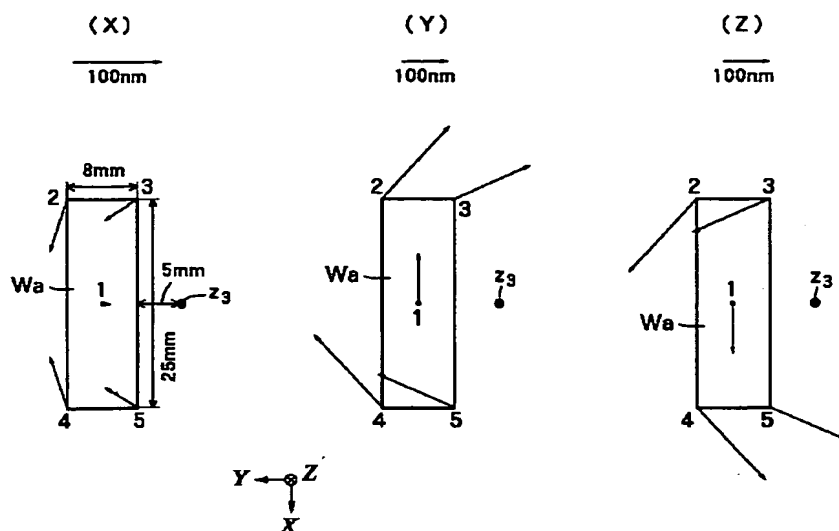

[Drawing 5]

[Drawing 4]

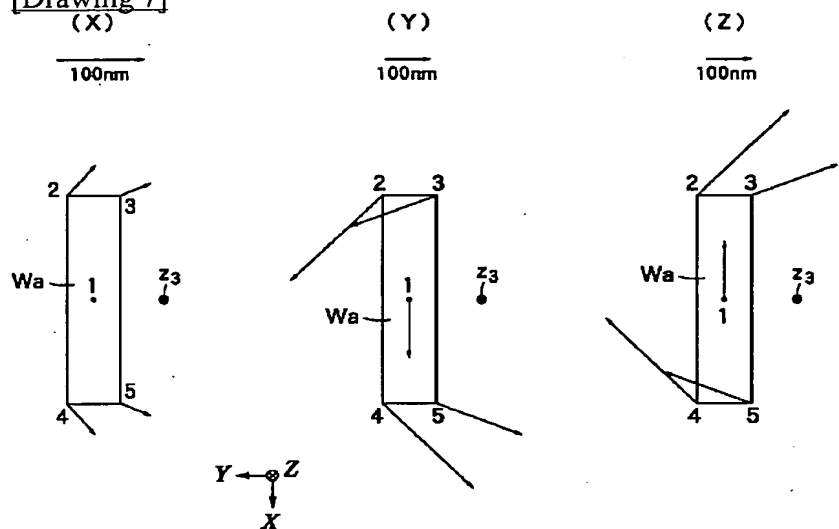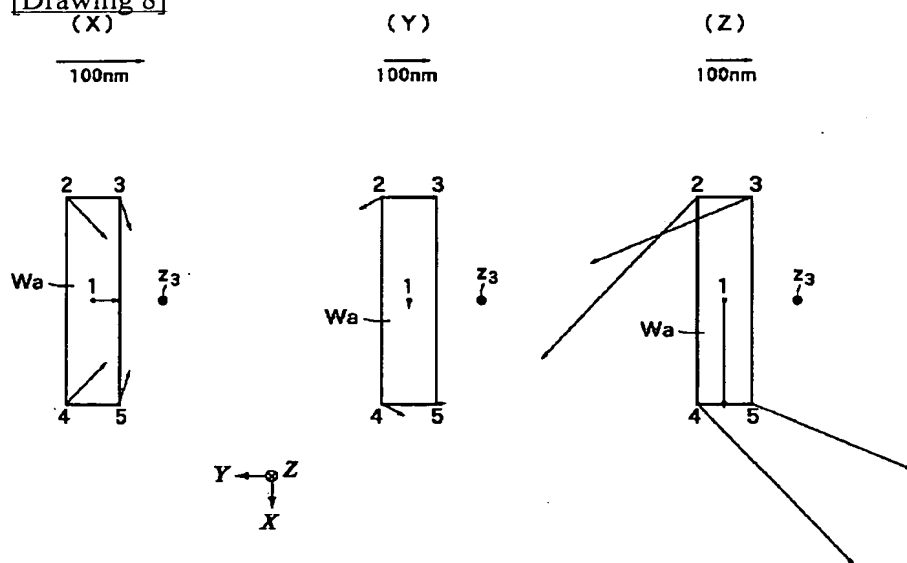(X)   (Y)   (Z)

100nm   100nm   100nm

[Drawing 6]

(X) (Y) (Z)

100nm 100nm 100nm

Y ← ⊗ Z
↓
X

[Drawing 7]

(X) (Y) (Z)

100nm 100nm 100nm

Y ← ⊗ Z
↓
X

[Drawing 8]

(X) (Y) (Z)

100nm 100nm 100nm

Y ← ⊗ Z
↓
X

[Translation done.]